

Tools for the Transfer of Strata Control Knowledge

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Analyses of accident records show that a better understanding of very basic strata control principles and practices, by production personnel, will improve worker safety. Workers lack of knowledge, with respect to aspects of strata control, increases their exposure to such strata control risks.

The primary objective of the Safety in Mines Research Advisory Committee (SIMRAC) project 02 02 07 was to develop tools for the transfer of strata control knowledge. Four such tools were developed, three of which focussed on illiterate underground mine team members who are not yet able to take advantage of the Mining Qualifications Authority (MQA) learning process (see project outcomes 2, 3 and 4 below). The tools were designed to equip these workers with sufficient knowledge and ability to work safely underground until such time as they can take advantage of the MQA system.

Project outcomes:

1. A four-minute video using animation to illustrate the causes and prevention of falls of roof in South African collieries.
2. Software to demonstrate the capability of reconstructing, interactively, accident scenes and actions that have taken place underground in stopes.
3. A strata control bridging course for illiterate mine team workers.
4. Small-scale wooden models that will be used to design life-size mock-up facilities to assist with the abovementioned bridging course.
5. Workshops and presentations to demonstrate the outcomes 1 to 4 above.

Introduction

It is clear from several in-depth assessments of accident records that a better understanding of very basic strata control principles and practices by production personnel will improve worker safety when considering the rockburst and rockfall hazard. Workers lack of knowledge with respect to aspects of strata control increases their and fellow workers' exposure to such strata control risks.

The primary objective of the Safety in Mines Research Advisory Committee (SIMRAC) project 02 02 07, reported here, was to develop tools for the transfer of strata control knowledge.

Initially the project was aimed at workers falling into the category of Mining Qualifications Authority (MQA) levels 1 to 4. During the initial work it was found that there was an important group of workers that did not fall into those categories and whose training requirements were not being addressed appropriately. This group comprised the many illiterate or semi-literate persons employed on the mine. It was decided to focus on this group and the scope of the project was then changed accordingly. Project outcomes 2,

3 and 4 below were then designed to equip these workers with sufficient knowledge and ability to work safely underground until such time as they can take advantage of the MQA system. A significant number of workers (up to

65% on some mines) fall into this category and it was felt the most impact would be achieved by focussing on this group.

Previous SIMRAC projects GAP414¹, GAP609a², GAP609b³ and GAP851⁴, all dealing with training material and methods of training (in theory and practice), provided a sound foundation upon which to base the project.

Project outcomes:

1. A four-minute video using animation to illustrate the causes and prevention of falls of roof in South African collieries.
2. Software to allow a rock engineer or safety officer to reconstruct a three dimensional representation of accidents on a mine, soon after they occur.
3. A training facilitator's booklet that sets out a strata-control bridging course for illiterate mine workers. The booklet lists the information to be taught and indicates how the trainer can get the information across to the workers.
4. Wooden models to facilitate strata control training and on which life size models for mock-up stopes can be based.
5. Workshops and presentations to demonstrate the abovementioned results.

Video animation –Causes of falls of roof in South African collieries

The SIMRAC project, COL618⁵, to determine the causes of falls of roof in South African collieries, was completed by van der Merwe, et al in 2001. At the request of SIMRAC the report was thoroughly reviewed and it was decided that a three dimensional, animated video would be the most efficient way of transferring the findings. A four minute video was produced showing various important fall of roof statistics and illustrating, by means of animation, how falls happen and how they can be prevented.



Figure 1 Animated video – Examples of scenes during the video introduction.

The video covers the most important findings of the COL618 report. It shows falls occurring in areas where there is inadequate support in highly laminated hangingwall rock, in more competent areas and where joints and faults are incorrectly supported. Figures 1 through 3 show some scenes from the video.



Figure 2 Animated video – Roof fall due to widely spaced bolting (highlighted).



Figure 3 Animated video – Improved bolt positioning (highlighted) and concluding scene.

Accident reconstruction software

The demonstration software (Figure 4) is named IPRAM (Interactive Programme for Reconstructing Accidents in Mines).



Figure 4 IPRAM software welcome window.

The software demonstrates the capability of reconstructing, interactively, accident scenes and actions that have taken place underground. It combines Virtual Reality and Multimedia techniques. The program will enable an operator (say a junior rock engineer on the mine) to interactively set up an accident scene using libraries of support, equipment, accident sites and sounds as well as personnel involved.

The demo software uses an accident associated with failure of a dome structure, common in the platinum mines, as an example. The library at this stage only includes 'virtual' 3D images of equipment, support, miners etc appropriate for *this* accident. (Figure 5). More images will have to be built up as required over time.

The software includes some animation showing the collapse of a wedge of rock from the hangingwall. The wedge will fail if not sufficiently well supported. It is clearly illustrated what happens in this type of accident. Different scenarios can be set up showing how miners can be injured by the falling wedge and then how this could have been prevented had adequate support been installed.

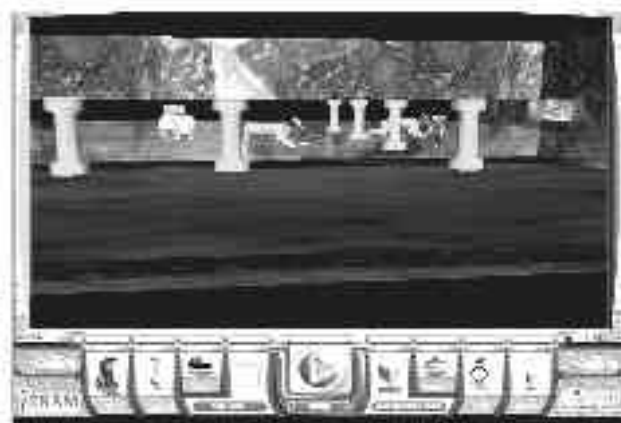


Figure 5 Stope scene showing various virtual images.

The reconstructions can be used for training of all levels of workers and could also be used at routine safety meetings and during campaigns on specific safety topics. The potential of such a program for rapid training is huge, especially when one considers it's interactive nature that allows specific accident scenes to be set up and played back.

Originally it was planned to use two-dimensional cartoon-like drawings to reconstruct accidents. Although this could be a viable option, it was felt that given the tools now available in multimedia, it would be a better option to go to a fully developed three dimensional program that could create more realistic reconstructions. These could be projected life-size and be better suited for training of mine workers.

Unfortunately, attempts to find additional financing to take the software beyond the demo model stage have proved unsuccessful so far. With further financing the program can be rolled out in stages. Numerous other common accident scenes can be developed and introduced thereby building up libraries of typical virtual images. The program could even be extended and shared via the internet to all mines in a group or to all mines involved with SIMRAC. This could add valuable input to overall safety measures as well as developing the sharing of ideas and developments that could benefit the mining industry as a whole and further promote South African global leadership in mining.

Strata control bridging course for illiterate workers - A facilitator's booklet

The material and methods of knowledge transfer in the bridging course are targeted at illiterate, underground mine team workers who are not yet able to take advantage of the MQA learning process. The course is designed to equip illiterate workers with sufficient knowledge and ability to work safely underground until such time as they can take advantage of the MQA system.

The booklet discusses all the topics that need to be covered and provides guidelines for the trainer and how to present the course. The interactive method of teaching and learning, recommended for this category of learner, is emphasised. It is recommended that life-size mock-up facilities be used. These can be based on models similar to those photographed and shown in the next section of the paper below. Here the learner will experience life-like occurrences, such as artificial falls of ground, by using harmless foam type materials. Figure 6 shows the work cycle, covered in the booklet, and the life-like experience mentioned above as the focus. There are links to all the functions of the work cycle as a reminder of what could happen if that part of the cycle is not completed properly.

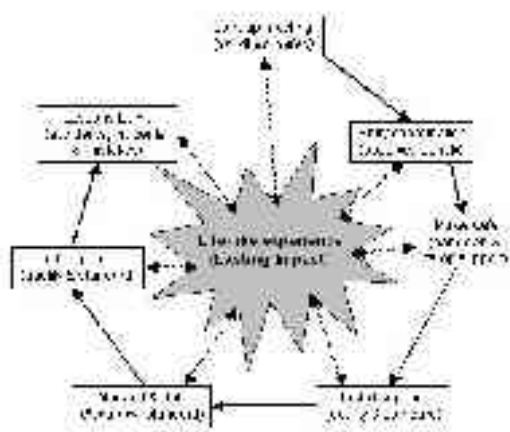


Figure 6 Basic work cycle covered in the 'Facilitator's Booklet'.

Instead of teaching, the facilitator will, with the correct guidance provided by the booklet, motivate the learners to

look, discuss, and try to solve and treat the issues at hand. The ultimate goal will be to stimulate or motivate the groups, in the course of the work cycle duties, to identify the typical range of conditions with which they could be confronted, and then to treat those conditions. The Facilitator's Booklet, therefore, is designed for the explicit use of the facilitator in the context of identifying strata control and mining induced hazards and issues, and how they are to be treated or addressed.

Included in the booklet are groups of typical or appropriate questions for the facilitator to use as he/she addresses each of the topics concerned. The questions are not limited to those printed in the book, and additional, more mine specific, questions should be added. The course is set out in Appendix 1 and the format used is that required by the MQA.

Practical methods of technology transfer

A life-size mock-up stope is a crucial part of the bridging course described above. Sketches were drawn up of what would be required for the strata-control bridging course in the mock-up stope. A model maker was then commissioned to construct scaled models upon which a mock-up facility could be based. Examples of two of the models are shown in Figures 7 and 8 below. Gold Fields Limited, in particular Gold Fields Academy and Driefontein Mine, have been involved with the project from the start and will test the bridging course. The abovementioned models have been loaned to them and there are plans to build life-size equivalents.

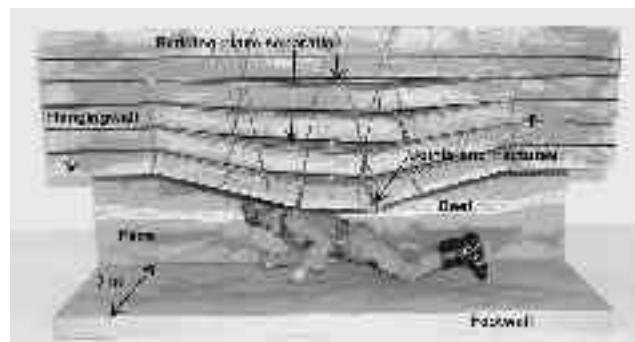


Figure 7 Section two metres from the face with no support resulting in bedding plane parting and opening up of joints in the hangingwall that could result in a FOG.

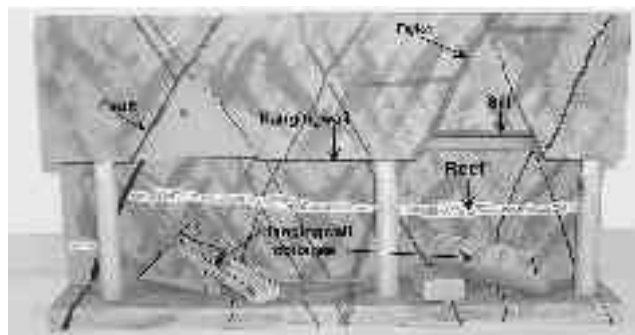


Figure 8 Section through a stope showing hangingwall collapse as a result of poor support in the vicinity of geological structures.

Technology transfer

Industry, the Dept of Minerals and Energy (DME) and the National Union of Mine Workers (NUM) were represented

on the steering committee and contributed significantly to the success of the project.

The video, illustrating the causes and prevention of falls of roof in coalmines described above, was distributed to interested parties.

An industry workshop was held on 23 October 2003 at the Driefontein Leadership Centre. Background and progress, with respect to the strata control bridging course, described above, was presented. The accident reconstruction software and the wooden models were also demonstrated at the workshop. The accident reconstruction software was also presented to senior executives and rock engineers at Anglo Platinum Corporation.

Summary and conclusions

- A need was identified for the transfer of basic strata control knowledge to the many workers who are illiterate and who cannot yet take part in the MQA levels 1 to 4 processes. The scope of the project was changed to develop a strata control course and method of presenting it to this category of underground worker. A booklet has been produced for the facilitator of such a course.
- The course requires the use of life-size mock-up facilities. Small-scale models were designed and manufactured upon which to base such a facility. Gold Fields, in particular Gold Fields Academy and Driefontein Mine, have been involved with the project from the start and will test the bridging course. The abovementioned models have been loaned to them and there are plans to build life-size equivalents.
- In addition, software has been written to demonstrate the capability of reconstructing, interactively, accident scenes and actions that have taken place underground in stopes. The program will enable an operator to interactively set up an accident scene using libraries of support, equipment, accident sites and sounds as well as the personnel involved. Different scenarios can be set up showing how miners can be injured by falling rock and then how this could have been prevented had adequate support been correctly installed. The potential of such a program for training is huge, especially when one considers its interactive nature that allows specific accident scenes to be set up and played back. Further development is strongly recommended.
- A four-minute video, that uses animation to illustrate the causes and prevention of falls of ground in collieries, has been distributed to interested parties. The video was based on the findings of SIMRAC project COL618 and was considered to be the most effective means of transferring the findings.
- Finally workshops and presentations were set up to demonstrate the tools for technology transfer.

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Appendix 1

Table 1 Training course – Basic information

FACILITATOR'S BOOKLET: STRATA CONTROL BRIDGING COURSE FOR ILLITERATE MINE TEAM WORKERS TRAINING MATERIAL			
SUBJECT	Basic strata control in hard rock mining (compatible with strata control component of MQA Unit Standard: MNH G078)		
TARGET POPULATION	Pre-MQA level 1 (totally illiterate team workers, not yet able to take advantage of the MQA learning process).	No. of learners.	10 maximum.
ABILITY	Illiterate, can speak own language, (usually not much english), can observe, identify, describe and participate in group work.	Duration.	As per individual or group of modules.
PRE-KNOWLEDGE	Experience of underground work ranges from limited to none at all.	Lesson type.	Facilitation / demonstration.
PURPOSE OF COURSE	Bridging course for the above category of worker to equip the person with sufficient ability and knowledge to work safely until such time when he or she can take advantage of the MQA system.	Course outcomes.	A candidate will be able to indicate and/or discuss the related hazards, identify them, treat them, and mention the consequences of ignoring such hazards.
EQUIPMENT (CLASS)	NB. For the most part the course will be presented in a mock-up facility but, on hand in the class should be: flip chart, white board, applicable mining models, samples of rock types, items of mining equipment and examples of applicable support. Recommended is projection equipment to project life-size accident reconstruction case studies should the software be available.	Venue. Introductory stage	Classroom & detailed surface "mock-up" stope, equipped with all the basic geological and mining induced hazards, working faces and full range of support units.

PHASE	CONTENT (FOR FACILITATOR'S USE AT THIS POINT)	LEARNER ACTIVITIES	FACILITATOR ACTIVITIES	TRAINING / VISUAL AIDS
INTRODUCTORY STAGE	The basic work cycle includes the following activities: • Meeting at the waiting place to discuss the day's planned activities • Entry examination • Making safe • Support • Mark off and drill • Charge up and blast. During the process of this work cycle, accidents / incidents occur, because hazards in the work place, particularly rock related, are not recognised or identified, and consequently get ignored. During this course but not necessarily in any particular order, the candidate will: • Learn the important geological & mining related hazards, and learn how to identify and treat the various conditions. • Become aware of effects of stress and seismicity on the rock -mass at the workplace and learn the basics of FOG's. • Become aware of the importance of accuracy in marking holes and drilling, and how damage to excav. can be caused by poor discipline in drilling and blasting. • Learn about quality support installation. • Understand the consequences of ignoring hazards, poor marking and drilling, and poor quality support installation. • Take heed of the lessons learnt from accident and incident investigations. In the classroom this can to a limited extent be achieved with the accident reconstruction software currently under construction (see illustration on next page)	During the introduction, learners need to become aware of the purpose of the course, and should participate as soon as possible.	The facilitator begins with a brief introduction, and outlines the course and class rules. The facilitator's task is motivating the learners into the mindset where identifying the hazards and treating them correctly, not only makes their working conditions safer, but also improves their productivity and earning power. The main objective is going to be enabling the learner where, when, and how to support correctly. To do this, the learner must learn to identify all the relevant hazards, and then know how to treat them. A major lasting impact needs to be imprinted on the learner's mind, i.e., by experiencing a simulated rock fall using non-injurious material in the mock-up stope. This simulated rock -fall, can be the life-like experience, to which all the phases of the learning process can be referred back (see Figure 1). It is, however, vitally important to ensure that the learner is made fully aware of the difference between the simulated rockfalls, which will be experienced at the mock -up stope, and the real event. The learner should be fully aware that real rocks injure and damage. The mine should consider setting up a safe drop test to show the potential to injure.	A properly and realistically equipped surface mock-up stope, preferably close to a classroom, must be the main venue for the facilitation. All the Geological and Mining Hazards mentioned / listed are to be realistically simulated within the confines of the mock-up stope, and adequate quantities of the various blasted rock types to be placed in the mock -up stope to simulate realistic conditions. All the typical mining tools and support units (with some installed and some not installed) to be available for instruction, practice, simulation and coaching. NB. Where it may be possible and appropriate to use models, it is important that the models are as close to life -size as possible, because it is considerably more meaningful to learners at this level.

Table 3 Training course – Specific outcome No. 1

SPECIFIC OUTCOME	CONTENT (ASSESSMENT CRITERIA)	LEARNER ACTIVITIES AND OUTCOMES	FACILITATOR ACTIVITIES	TYPICAL QUESTIONS FOR THE FACILITATOR TO ASK
SPECIFIC OUTCOME No. 1 The basic geological discontinuities and mining induced hazards are identified in the mock-up work place together with the need to support them.	Geological discontinuities and Mining induced hazards can be associated with a large percentage of the falls of ground accidents / incidents occurring in hard rock mining. We want the learner to support the geological discontinuities and mining induced hazards correctly, and therefore first learn how to identify them. Collectively, the following generic list of basic geological discontinuities, and mining induced hazards, is what needs to be taught for identification: JOINTS, FAULTS, DYKES, AND SILLS BEDDING PLANES & BED SEPARATION REEF ROLLS KEY BLOCKS FRACTURING BROWS AND THEIR FORMATION LOOSE ROCKS In practice at this level, it will be logical to group the above into four categories: FRACTURES (all types) FAULTS (displacement) BROWS (h/wall shape) LOOSE ROCKS The treatment for all of the conditions above, will be similar - correctly installed support. NB. The content of this specific outcome is applicable to all sectors of the work cycle mentioned in the introduction, and must be one of the topics discussed at daily meetings.	At this stage, the learner must have experienced the simulated rock -fall within the mock-up stope, exposing him or her to a typical situation of “what can easily happen if ?”..... The learner now enters the mock –up stope with the facilitator and the rest of the group of learners, bearing in mind his or her recent experience, and examines the other various simulated hazards in the mock -up. The learner discusses with his/her co-learners and answers or responds to questions posed by the facilitator. As a result, the learners recognise, relate to, and learn about the “depicted hazards”, through participation and discussion with their peers and the facilitator. By the end of this session the learners will demonstrate that they can identify and discuss all the relative hazards, and that they must occurrence of a fall of ground, similar to the “experience” at the beginning of the course.	The facilitator must be fully conversant with the subject material. The objectives are now well documented. We want the learner to support correctly. To do that, the learner must know the hazard, and identify it. With “the experience” fresh in the minds of the learners, the facilitator leads the group to each of the simulated hazards in the mock-up stope. At each discontinuity he should pause, indicate that the area should be scrutinised, and then begin facilitating / coaching learners to recognise / identify / treat the hazard by directing or getting the learners to ask relevant questions between themselves, e.g. what does this look like? Is there a danger, what is dangerous? why is it dangerous? etc. Coaching the learners to discuss and question the issues as a group encourages meaningful learning and also promotes many of the CCFOs, i.e. team work, problem solving, communications, and leadership, etc.,	Do you feel safe here? If no, why not? If yes, why? Look at the rock surfaces at the sides and above you - what do you see? What is preventing the rock(s) from falling? What do you think is causing the rock to be fractured? What will happen if some of the broken rock falls out? What will happen to the workers if the rock falls? What will happen to the tools and equipment if rock falls? Can something be done to prevent the rock from falling? How will this prevent the rock from falling, today, tomorrow, & everyday? How will you benefit from installing support properly, daily? How does the mine benefit by you installing support properly each day? How does your family benefit by you installing support properly everyday.

SPECIFIC OUTCOME	CONTENT (ASSESSMENT CRITERIA)	LEARNER ACTIVITIES AND OUTCOMES	FACILITATOR ACTIVITIES	TYPICAL QUESTIONS FOR THE FACILITATOR TO ASK
SPECIFIC OUTCOME No.2 Basic issues relating to Falls of Ground are mentioned, and indicated in the mock-up work place.	The learners will be reminded that so far, they have been introduced to disturbed rock in the form of fractures and discontinuities of both geological and mining induced nature. It will be extremely difficult for learners at this level, to differentiate between all the different types of fractures. Rather, they should simply learn “what actions”, or how “lack of due care” in their daily tasks, contribute to the instability of rock, and consequently falls of ground. An area in which the learner can reduce the risk of F.O.G.s and requiring considerable attention by the facilitator, is the barring / supporting / drill and blast function. Poor barring methods, badly installed support, inaccurate drilling of blast-holes coupled with poor use of explosives, are all responsible for a large proportion of F.O.G.s. It is therefore essential to include in the facilitation / coaching process: POOR BARRING TECHNIQUES - loose rocks not barred down POOR SUPPORT INSTALLATION - large unsupported spans & poor construction / application of support	In the mock-up stope with the facilitator, the learners examine the various simulated fractures and hazardous conditions, pointed out by the facilitator, discuss what they see with their co - learners and answer / respond to questions posed by the facilitator. As a result, the learner is able to recognise, identify, relate to, or learns about other hazards, such as blasting fractures caused by poor drilling and blasting, loose rocks, as a result of poor barring, loose rock and FOGs as a result of unsupported rock wall. In Specific Outcome 2, the learner will be able to recognise that fractures are created. The learner may not be able to differentiate between the various causes of fractures but he/she knows that some of the fractures and the danger they pose can be eliminated/reduced by barring, supporting, and drilling according to the required mine specific standards. The learner must also be able to identify key blocks, and mention what happens to the hangingwall, as a result of excessive spans between support units, and also excessive spans between support units and the face/sidewalls, as a result of blast damaged/removed or missing support.	The facilitator will use the same process as described in SO 1. Trainer subject knowledge is essential, and again, use needs to be made of the simulated polystyrene fall of ground demonstrations, to demonstrate some of the concepts especially related to falls of ground. The learners must be shown the difference between the right and wrong areas depicted in the mock up for : drilling, barring, support installation, blast damaged and removed support. Emphasis to be directed to aspects of poor quality drilling, which create more fractures and potential FOGs. Learners must discuss what they see amongst themselves, and make comment. The same applies to poorly installed and blast damaged support.	Comparing the "good and bad" areas: Which hanging wall looks safer to you?.....Why?...What do you see? Are you feeling safe in the "bad area"?... Why? If there are loose rocks in the hanging-wall, can you see them? What should you do about them, and how do you do it? What happens when all the fractures intersect? Is it dangerous? If yes, why?... What should be done to make safe? What do you see happening in the hangingwall, if blast holes are too far apart? ..or not drilled in the pattern of the mine standard? How do you correct this? What do you see happening in the hanging-wall when the blast holes are too close together ? If the support is badly installed , do you feel safe next to it? Why not? What should you do about it? What do you think happens to the hanging-wall when the support is placed too far apart? Do you feel safe or not?

SPECIFIC OUTCOME	CONTENT (ASSESSMENT CRITERIA)	LEARNER ACTIVITIES AND OUTCOMES	FACILITATOR ACTIVITIES	TYPICAL QUESTIONS FOR THE FACILITATOR TO ASK
SPECIFIC OUTCOME No. 3 The reasons for damage to the rock face, caused by poor drilling practices and the relevant consequences, are identified and mentioned	POOR DRILLING DISCIPLINE - hanging-wall related blasting fractures BLAST DAMAGED/REMOVED SUPPORT - in both stope and off-reef excavations. From the previous Specific Outcome (No. 2) the learners are now aware that poor quality drilling is one of the factors which can increase the fracturing problem in the hangingwall when the holes get blasted. and as a result, increase the risk of falls of ground. In this specific outcome, the learners are made aware that they can have a major influence on the amount of fracturing in the hanging-wall or side-wall, depending on the quality of their drilling operations. The following issues have been touched on, in the previous SO, but are to	The learner enters the mock-up stope with the facilitator and proceeds to the simulated face (stope side wall or side wall) and discusses correct and incorrect marking and drilling and the relevant consequences can be seen. The learner examines the simulated conditions and hazards, discusses, and answers / responds to questions by the facilitator. As a result of this, the learner will physically identify the difference between correct and incorrect marking and drilling of blast holes, and give some indication of why it is important. After discussion and facilitation the learner	The same facilitation process is applied as in the previous Specific Outcomes, and trainer subject knowledge is essential. Emphasis must be placed on the following: Fracturing as a result of inaccurate, badly spaced, and poor quality drilling and blasting practices increases the chances of: falls of ground, injuries, loss of production, and requires more support to prevent those FOGs, generally slowing down production.	The places to drill blastholes are marked for us . Why is it important to collar the holes as accurately as possible? Does it matter if the direction of the holes are not all the same? Why is it important that the hole directions must all be the same? Is it good to drill into the hangingwall or footwall, with the holes? Why or why not? What happens to the hangingwall

	or the potential influence on ground conditions: 1) accuracy of collaring the holes. 2) accuracy of direction, i.e. following the painted direction lines. 3) accuracy of drilling holes parallel to the hanging-wall and foot-wall. 4) all shot holes to be the same length. (NB. It must be noted that marking of holes and charging up procedures, are the responsibility of the holder of a blasting certificate.)	will help reduce the creation of unnecessary fractures and hence risk of falls of ground: 1) accuracy of collaring the shot -holes. 2) following and drilling according to the direction lines given. 3) accuracy of drilling parallel to hanging and footwall. 4) keeping the length of holes all the same length. The learners will also be able to mention other benefits of adhering to correct standard procedures, such as achieving better face advance(and therefore bonus), safer working conditions, less additional support for unnecessary fracturing etc.	A regular, accurately and evenly drilled face has to be the motivation for this type of practice, which ultimately improves productivity, safety, and reward. For this particular specific outcome, a simulated stope face is required, which allows access to both the face and behind the face, in order to demonstrate and explain the consequences of in -accurate drilling and blasting practices.	What happens to the rock if one hole is drilled shorter than the others? Does it help the operator to drill short holes? Why, or why not? Can you explain how all these four practices influence the condition of the hanging in the place where you work?
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Table 6 Training course – Specific outcome No. 4

SPECIFIC OUTCOME	CONTENT (ASSESSMENT CRITERIA)	LEARNER ACTIVITIES AND OUTCOMES	FACILITATOR ACTIVITIES	TYPICAL QUESTIONS FOR THE FACILITATOR TO ASK
SPECIFIC OUTCOME No.4 The indications of badly constructed / damaged and non-standard spaced / installed support are identified, and the effects are mentioned.	This specific outcome concerns the quality of support installation, and the learners need to recognise the issues and consequences of poorly constructed support, incorrectly spaced support, or damaged support. Sub-standard quality of support installation, and damaged support, reduces the effectiveness of the support. In doing this, it increases loading on the neighbouring support, and / or it has the effect of increasing the unsupported span between support units, and between support units and the face. As a result, the risk of falling ground is increased. The essential basic points of this outcome are: 1) Correctly overlapped layers in pack construction, if not using slabs. 2) All support units to be installed perpendicular to dip of reef, i.e. perpendicular to the strata. 3) All stope support units to be sized and cut correctly for stoping width and correct for width to height ratio. 4) Support units to be pre-stressed where the	The learners enter the mock – up stope and proceed to the supported areas (either in a tunnel or stope situation) They will observe examples of all facets of sub-standard quality installations, including damaged support, incorrect width to height ratio, large unsupported spans, with FOGs evident, where the spans are too big. They must also observe correctly installed and spaced support, according to the mine's required standard. The learners will observe, compare, discuss, and see the difference between correct and incorrect installations By the end of this specific outcome, the learners will be able to identify the differences between what is correct and what is incorrect, and know that the consequences of incorrect installation and spacing will lead to FOGs. The learners will also be able to identify and mention the consequences of large	Subject knowledge is essential, and the same facilitation process is used. The facilitator must ensure that the learners see, discuss, compare, and completely understand that, imperfectly installed support is a hazard both to the learner and their co-workers. The results could lead to serious FOGs in the workplace, and thus, not only potential injury to workers but also, loss of earnings and production. A simulated fall of ground must be included in the support area, where unsupported spans are far beyond the mine standard. The accident re-construction software could well be utilised here to demonstrate the effects	When building packs using "slabs", why is it important that all the slabs are correctly lined up vertically? Why is it important to install support 90° to the hanging-wall or strata? What happens if an elongate type of support is not installed 90° to the hanging wall? If elongate type support units are buckling in the stope, what is the reason for this? What will happen if the problem is not addressed quickly? Why do we pre-stress support units? What does it do to the hangingwall? Why must support be sized against the stoping width, and cut accurately? What will happen if it is not cut accurately? If support units are installed further apart than the mine specific standard requires, what will happen? Why will it happen?

	mine standard requires it. 5) All support units to be installed according to prescribed standards both stoping and development. Remember the standard is always the minimum requirement. Damaged support in the working area is a hazard, and must be replaced according to regulation.	badly constructed, or installed, or damaged support, and the appropriate action to be taken, in order to re-support.	spans, and how supporting according to the mine specified requirements improves the hanging-wall stability. Once again, this type of visual must be close to life-size.	
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Table 7 Training course – Specific outcome No. 5

SPECIFIC OUTCOME	CONTENT (ASSESSMENT CRITERIA)	LEARNER ACTIVITIES AND OUTCOMES	FACILITATOR ACTIVITIES	TYPICAL QUESTIONS FOR THE FACILITATOR TO ASK
SPECIFIC OUTCOME No.5 The lessons learnt from accident investigations are noted and mentioned.	This topic is important in the context that accidents frequently re-occur. They re-occur because the critical issues of such accidents may not reach the team worker, and even if it does, there remains a lack of awareness. We learn by experience, positive or otherwise, and one method to address the issue is to discuss incidents / accidents as soon as details are made available. This enables the team / group to learn from the available information, and prevent re-occurrences from taking place. The suitable time and venue for such group meetings would be at the waiting place, prior to entering the workplace. In the event of the team worker not being able to read, the team leader / miner should provide the information, which has been posted on the notice board at the waiting place. The discussion should be lead in a risk assessment type investigation, i.e., what happened, apparent cause, basic cause, how do we prevent it from happening again, or happening to our team in our working place.	This is very much a group discussion topic, and during the learning stage, could take place either in the waiting place for the mock-up stope, or the classroom. Naturally, after training is complete, the ideal time and place is the waiting place, prior to stope entry. The learners will participate, discuss and learn that it is important to take note of accidents, incidents / occurrences, and even near misses, which are taking place elsewhere in the mine's working environment. It is also important to hear / know what were the causes of these accidents / incidents, and how were they dealt with. By the end of Specific Outcome No. 5 the learners will understand the need and mention the process relating to discussion of accidents, after they have occurred, and how the issues are dealt with in order to prevent re-occurrence of the same events.	The facilitator must ensure that the learners fully understand the purpose of this outcome, and how it can benefit them to hear and talk about accidents / incidents elsewhere on the mine, at the waiting place. By doing so, and becoming aware of the risks that might have been "overlooked or ignored", learners will learn to prevent similar accidents / occurrences in their working places.	What happened in the FOG at the beginning of this course? Why do you think the rocks fell? Knowing what you know now, could you have prevented it? Will you be able to prevent similar FOGs in other places in the future? If yes, what will you do to prevent a re-occurrence? What signs or indications will you be looking for to prevent similar FOGs places.